miniLAB 1008

Eight Analog Input, Two Analog Outputs, and Four Digital I/O

User's Guide

MEASUREMENT COMPUTING™

miniLAB 1008™

USB-based
Analog and Digital I/O Module

User's Guide

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About this User's Guide

What you will learn from this user's guide

This user's guide explains how to install, configure, and use the miniLAB 1008. This guide also refers you to related documents available on our web site, and to technical support resources.

Conventions in this user's guide

For more information on …

Text presented in a box signifies additional information and helpful hints related to the subject matter you are reading.

Caution! Shaded caution statements present information to help you avoid injuring yourself and others, damaging your hardware, or losing your data.

<#:#> Angle brackets that enclose numbers separated by a colon signify a range of numbers, such as those assigned to registers, bit settings, etc.

bold text **Bold** text is used for the names of objects on the screen, such as buttons, text boxes, and check boxes. For example:
1. Insert the disk or CD and click the **OK** button.

italic text *Italic* text is used for the names of manuals and help topic titles, and to emphasize a word or phrase. For example:
The *Insta*Cal® installation procedure is explained in the *Quick Start Guide*.
Never touch the exposed pins or circuit connections on the board.

Where to find more information

The following electronic documents provide helpful information relevant to the operation of the miniLAB 1008.

- MCC's *Specifications: miniLAB 1008* (the PDF version of the Electrical Specification Chapter in this guide) is available on our web site at www.mccdaq.com/pdfs/minilab-1008.pdf.
- MCC's *Quick Start Guide* is available on our web site at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.
- MCC's *Guide to Signal Connections* is available on our web site at www.mccdaq.com/signals/signals.pdf.
- MCC's *Universal Library User's Guide* is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-user-guide.pdf.
- MCC's *Universal Library Function Reference* is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.
- MCC's *Universal Library for LabVIEW™ User's Guide* is available on our web site at www.mccdaq.com/PDFmanuals/SM-UL-LabVIEW.pdf.

miniLAB 1008 User's Guide (this document) is also available on our web site at www.mccdaq.com/PDFmanuals/minilab-1008.pdf.

Introducing the miniLAB 1008

This user's guide contains all of the information you need to connect the miniLAB 1008 to your computer and to the signals you want to measure.

The miniLAB 1008 is a USB 1.1 low-speed analog and digital I/O device that is supported under popular Microsoft® Windows® operating systems. The miniLAB 1008 is fully compatible with both USB 1.1 and USB 2.0 ports.

The miniLAB 1008 features eight 12-bit analog input signal connections and 28 digital I/O connections. It is powered by the +5 volt USB supply. No external power is required.

Two screw terminals rows provide connections for eight analog inputs, two 10-bit analog outputs, four bidirectional digital I/O lines, and one 32-bit external event counter. You can configure the analog input connections with software as either four single-ended or eight differential channels. All analog connections terminate at the screw terminals.

24 bidirectional digital I/O lines are also available on a 37-pin connector.

An on-board industry standard 82C55 programmable peripheral interface chip provides 24 digital I/O lines that terminate at a 37-pin connector.

The miniLAB 1008 USB device is shown in Figure 1-1.

Figure 1-1. miniLAB 1008

miniLAB 1008 block diagram

miniLAB 1008 functions are illustrated in the block diagram shown here.

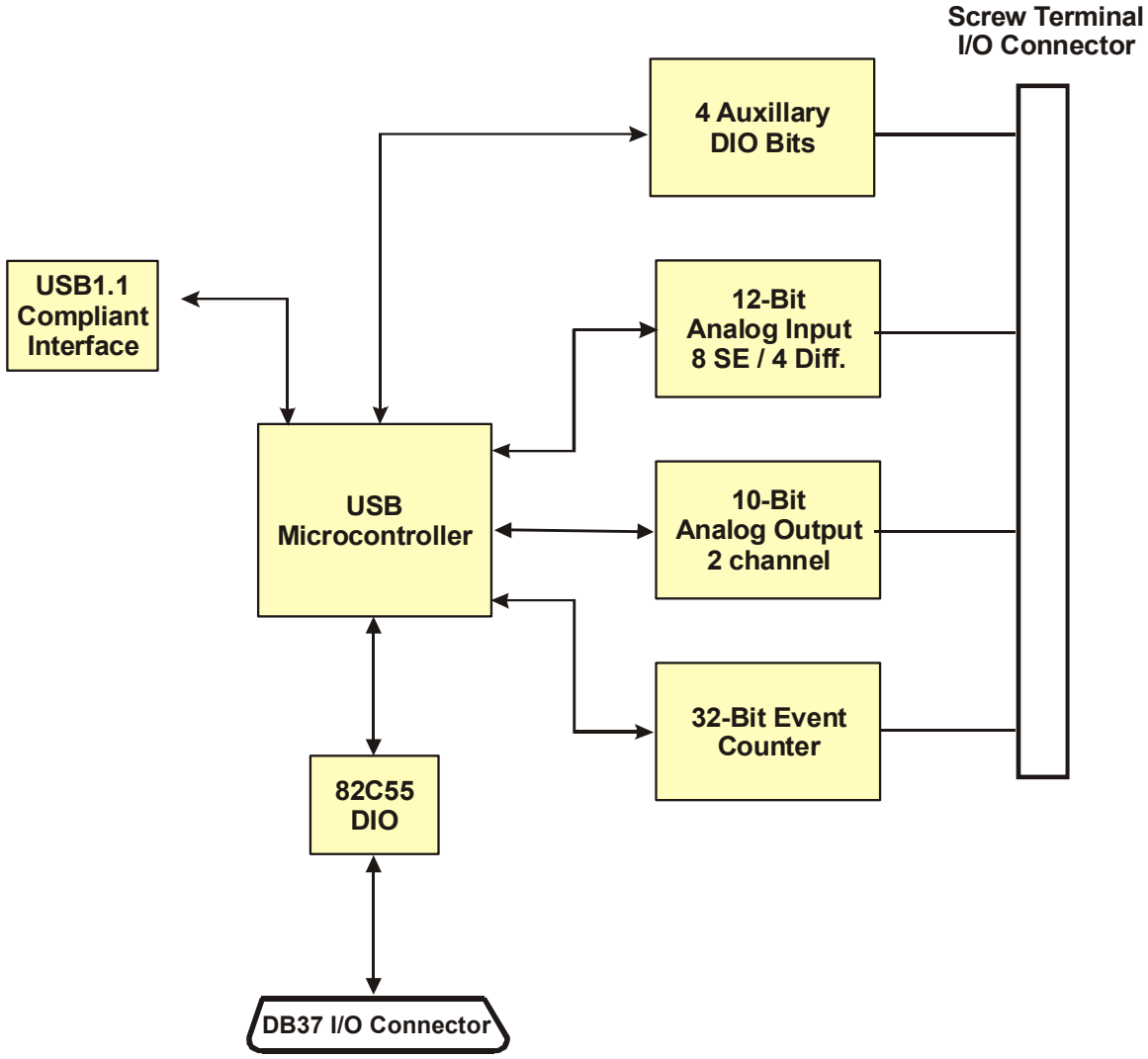


Figure 1-2. miniLAB 1008 Functional Block Diagram

Software features

For information on the features of *Insta*Cal and the other software included with your miniLAB 1008, refer to the *Quick Start Guide* that shipped with your device. The *Quick Start Guide* is also available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Check www.mccdaq.com/download.htm for the latest software version or versions of the software supported under less commonly used operating systems.

Connecting a miniLAB 1008 to your computer is easy

Installing a data acquisition device has never been easier.

- The miniLAB 1008 relies upon the Microsoft Human Interface Device (HID) class drivers. The HID class drivers ship with every copy of Windows that is designed to work with USB ports. We use the Microsoft HID because it is a standard, and its performance delivers full control and maximizes data transfer rates for your miniLAB 1008. No third-party device driver is required.
- The miniLAB 1008 is plug-and-play. There are no jumpers to position, DIP switches to set, or interrupts to configure.
- You can connect the miniLAB 1008 before or after you install the software, and without powering down your computer first. When you connect an HID to your system, your computer automatically detects it and configures the necessary software. You can connect and power multiple HID peripherals to your system using a USB hub.
- You can connect your system to various devices using a standard four-wire cable. The USB connector replaces the serial and parallel port connectors with one standardized plug and port combination.
- You do not need a separate power supply module. The USB automatically delivers the electrical power required by each peripheral connected to your system.
- Data can flow two ways between a computer and peripheral over USB connections.

Installing the miniLAB 1008

What comes with your miniLAB 1008 shipment?

As you unpack your miniLAB 1008 device, verify that the following components are included:

Hardware

- miniLAB 1008 device

- USB cable

Additional documentation

In addition to this hardware user's guide, you should also receive the *Quick Start Guide* (available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf). This booklet supplies a brief description of the software you received with your miniLAB 1008 and information regarding installation of that software. Please read this booklet completely before installing any software or hardware.

Unpacking the miniLAB 1008

As with any electronic device, you should take care while handling to avoid damage from static electricity. Before removing the miniLAB 1008 from its packaging, ground yourself using a wrist strap or by simply touching the computer chassis or other grounded object to eliminate any stored static charge.

If your miniLAB 1008 is damaged, notify Measurement Computing Corporation immediately by phone, fax, or e-mail. For international customers, contact your local distributor where you purchased the miniLAB 1008.

- Phone: 508-946-5100 and follow the instructions for reaching Tech Support.
- Fax: 508-946-9500 to the attention of Tech Support
- Email: techsupport@mccdaq.com

Installing the software

Refer to the *Quick Start Guide* for instructions on installing the software on the *Measurement Computing Data Acquisition Software CD*. This booklet is available in PDF at www.mccdaq.com/PDFmanuals/DAQ-Software-Quick-Start.pdf.

Installing the hardware

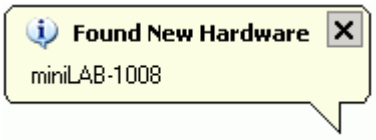
Be sure you are using the latest system software

Before you connect the miniLAB 1008, make sure that you are using the latest versions of the USB drivers.

Before installing the miniLAB 1008, download and install the latest Microsoft Windows updates. In particular, when using Windows XP, make sure you have XP Hotfix KB822603 installed. This update is intended to address a serious error in Usbport.sys when you operate a USB device. You can run Windows Update or download the update from www.microsoft.com/downloads/details.aspx?familyid=733dd867-56a0-4956-b7fe-e85b688b7f86&displaylang=en. For more information, refer to the Microsoft Knowledge Base article "*Availability of the Windows XP SP1 USB 1.1 and 2.0 update.*" This article is available at support.microsoft.com/?kbid=822603.

To connect the miniLAB 1008 to your system, turn your computer on, and connect the USB cable to a USB port on your computer or to an external USB hub that is connected to your computer. The USB cable provides power and communication to the miniLAB 1008.

When you connect the miniLAB 1008 for the first time, a **Found New Hardware** popup balloon (Windows XP) or dialog (other Windows version) displays as the miniLAB 1008 is detected by your computer.



Another **Found New Hardware** balloon or dialog opens after the first closes that identifies the miniLAB 1008 as a USB Human Interface Device. This balloon or dialog indicates that your miniLAB 1008 is installed and ready to use.

When the balloon or dialog closes, the LED on the miniLAB 1008 should flash and then remain lit. This indicates that communication is established between the miniLAB 1008 and your computer.

Caution! Do not disconnect **any** device from the USB bus while the computer is communicating with the miniLAB 1008, or you may lose data and/or your ability to communicate with the miniLAB 1008.

If the LED turns off

If the status LED is illuminated but then turns off, the computer has lost communication with the miniLAB 1008. To restore communication, disconnect the USB cable from the computer, and then reconnect it. This should restore communication, and the LED should turn back *on*.

Functional Details

Theory of operation - analog input acquisition modes

The miniLAB 1008 can acquire analog input data in three different modes – software paced, continuous scan, and burst scan.

Software paced mode

In software paced mode, the miniLAB 1008 gathers data in a single acquisition or as a group of single acquisitions. An analog-to-digital conversion is initiated with a software command, and the single data point result is returned to the host. This operation may be repeated until the required number of samples is obtained for the channel (or channels) in use. Software pacing is limited by the 20 mS round-trip requirement of a USB interrupt-type endpoint operation. This yields a maximum throughput in software paced mode of 50 S/s.

Continuous scan mode

In continuous scan mode, the miniLAB 1008 gathers data in a single-channel or multi-channel sequence. This sequence converts, transfers, and stores data to a user buffer until the scan is stopped. In this mode, digitized data is continuously written to an on-board FIFO buffer. This FIFO is serviced in blocks as the data is transferred from the miniLAB 1008 to the user buffer in the host PC.

The maximum continuous scan rate of 1.2 kS/s is an aggregate rate. The total acquisition rate for all channels cannot exceed 1.2 kS/s. You can acquire data from one channel at 1.2 kS/s, two channels at 600 S/s and four channels at 300 S/s. You can start a continuous scan with either a software command or with an external hardware trigger event.

Burst scan mode

In burst scan mode, the miniLAB 1008 gathers data using the full capacity of its 4 K sample FIFO buffer. You can initiate a single acquisition sequence of one, two, or four channels by either a software command or an external hardware trigger. The captured data is then read from the FIFO and transferred to a user buffer in the host PC.

Since the data is acquired at a rate faster than it can be transferred to the host, burst scans are limited to the depth of the on-board memory. As with continuous mode, the maximum sampling rate is an aggregate rate. Consequently, the maximum burst mode rates are 8 kS/s, 4 kS/s and 2 kS/s for one, two and four channels, respectively.

External components

The miniLAB 1008 has the following external components, as shown in Figure 3-1.

- USB connector
- Status LED
- Digital I/O connector
- Screw terminal banks (2)

Figure 3-1. miniLAB 1008 external components

USB connector

The USB connector is located on the bottom edge of the miniLAB 1008. This connector provides +5 V power and communication. The voltage supplied through the USB connector is system-dependent, and may be less than 5 V. No external power supply is required.

Caution! The **USB +5V Out** pins on the DB37 connector are outputs. Do not connect an external 5 V supply or you may damage the miniLAB 1008 and possibly the computer.

Status LED

The **STATUS** LED on the front of the miniLAB 1008 indicates the communication status. It uses up to 5 milliamperes (mA) of current and cannot be disabled. Table 3-1 explains the function of the miniLAB 1008 LED.

Table 3-1. LED Illumination

When the LED is…	It indicates…
Steady	The miniLAB 1008 is connected to a computer or external USB hub.
Blinks continuously	Data is being transferred.
Blinks three times	Initial communication is established between the miniLAB 1008 and the computer.
Blinks at a slow rate	The analog input is configured for external trigger. The LED stops blinking and illuminates steady green when the trigger is received.

Digital I/O connector and pin out

Digital I/O connections are made to the DB37 connector on the top edge of the miniLAB 1008. This connector provides connections for 24 digital lines (**Port A0** to **Port C7**), six ground connections (**GND**), and two power output terminals (**USB +5V Out**). Refer to Figure 3-2 and Table 3-2 for the DB37 connector pin out.

Digital I/O connections (Port A0 through Port C7)

The 24 digital I/O pins (**Port A0-A7**, **Port B0-B7** and **Port C0-C7**) are TTL-level compatible. Each pin has a 47 kilohm (kΩ) pull-up resistor and is configured as an input by default. If needed, the miniLAB 1008 can be factory configured to provide pull-down resistors.

Caution! Port A0 through Port C7 have no overvoltage/short circuit protection. Do not exceed the voltage limits or you may damage the pin or the miniLAB 1008. To protect these pins, you should use a series resistor.

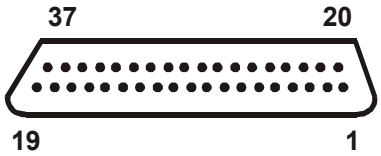


Figure 3-2. DB37 Digital I/O connector

Table 3-2. DB37 connector pin out

Pin	Signal Name	Pin	Signal Name
1	n/c	20	USB +5V Out
2	n/c	21	GND
3	Port B7	22	Port C7
4	Port B6	23	Port C6
5	Port B5	24	Port C5
6	Port B4	25	Port C4
7	Port B3	26	Port C3
8	Port B2	27	Port C2
9	Port B1	28	Port C1
10	Port B0	29	Port C0
11	GND	30	Port A7
12	n/c	31	Port A6
13	GND	32	Port A5
14	n/c	33	Port A4
15	GND	34	Port A3
16	n/c	35	Port A2
17	GND	36	Port A1
18	USB +5V Out	37	Port A0
19	GND		

Refer to the "Digital connector cabling" section for descriptions of cables that are compatible with the DB37 digital I/O connector.

Caution! The **USB +5V Out** pins on the DB37 connector are outputs. Do not connect an external 5 V supply or you may damage the miniLAB 1008 and possibly the computer.

Screw terminal wiring

The miniLAB 1008 has two rows of screw terminals. Each row has 15 connections. Pin numbers are identified in Figure 3-3. The pins are labeled for eight-channel single-ended mode operations.

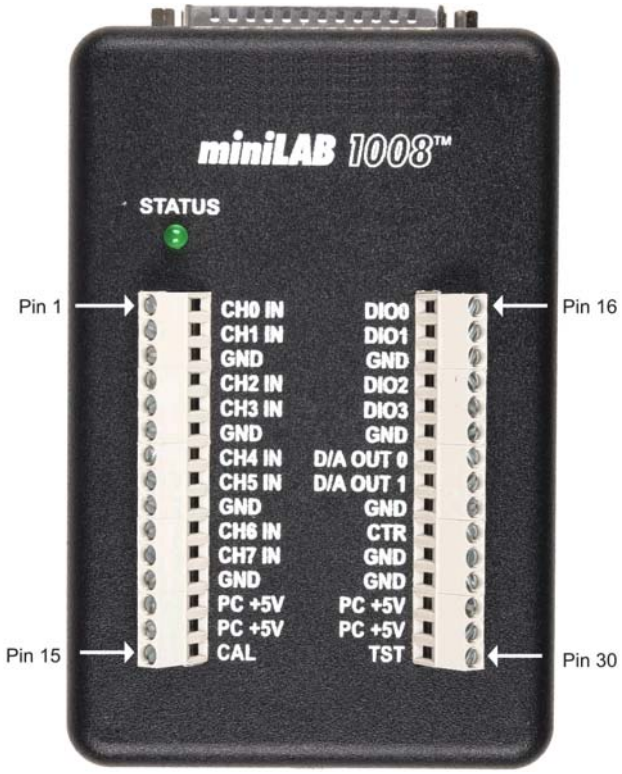


Figure 3-3. miniLAB 1008 screw terminals

Screw terminal pins 1-15

The screw terminals on the left edge of the miniLAB 1008 (pins 1 to 15) provide the following connections:

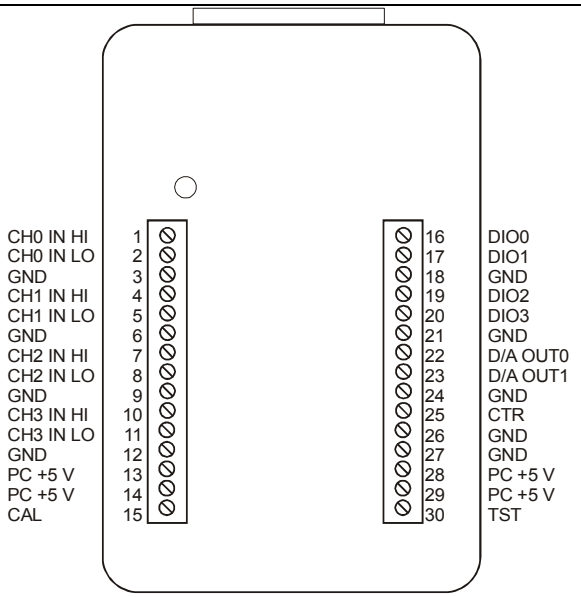
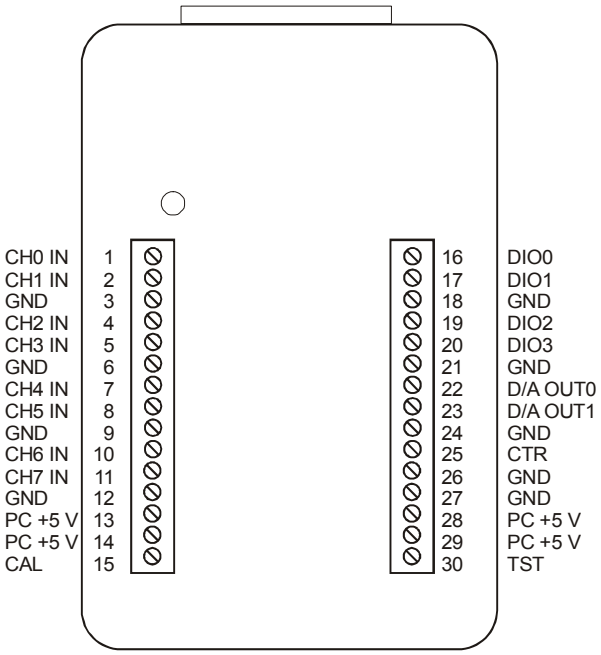
- Eight analog input connections (**CH0 IN** to **CH7 IN**)
- Four GND connections (**GND**)
- One calibration terminal (**CAL**)
- Two power connectors (**PC +5 V**)

Screw terminal pins 16-30

The screw terminals on the right edge of the miniLAB 1008 (pins 16 to 30) provide the following connections:

- Four digital I/O connections (**DIO0** to **DIO3**)
- Two analog output connections (**D/A OUT 0** to **D/A OUT 1**)
- One external event counter connection (**CTR**)
- One testing and calibration terminal (**TST**)
- Five ground connections (**GND**)
- Two power connectors (**PC +5 V**)

Main connectors and pin outs

Connector type	Screw terminal
Wire gauge range	16 AWG to 26 AWG
4-channel differential mode pin out Note that the pins are labeled for 8-channel single-ended mode on the miniLAB 1008.	
8-channel single-ended mode pin out Note that the pins are labeled for 8-channel single-ended mode on the miniLAB 1008.	

Analog input terminals (CH0 In - CH7 In)

Connect up to eight analog input connections to the screw terminal connections labeled **CH0 In** through **CH7 In**. Refer to the pinout diagrams on page 3-5 for the location of these pins.

You can configure the analog input channels as eight single-ended channels or four differential channels. When configured for differential mode, each analog input has 12-bit resolution. When configured for single-ended mode, each analog input has 11-bit resolution, due to restrictions imposed by the A/D converter.

Single-ended configuration

When all of the analog input channels are configured for single-ended input mode, eight analog channels are available. In single-ended mode, the input signal is referenced to signal ground (GND). The input signal is delivered through two wires:

- The wire carrying the signal to be measured connects to CH# IN.
- The second wire connects to GND.

The input range for single-ended mode is ±10 V max, with a gain of 2. No other gains are supported in single-ended mode.

Figure 3-4 illustrates a typical single-ended measurement connection.

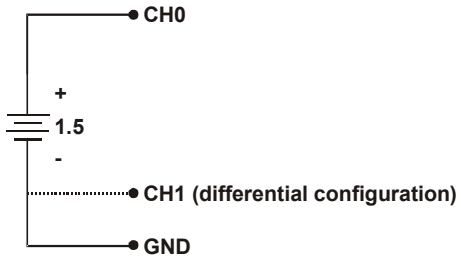


Figure 3-4. Single-ended measurement connection

Single-ended measurements using differential channels

To perform a single-ended measurement using differential channels, connect the voltage to an analog input with an even-number, and ground the associated odd-numbered analog input. This configuration is shown in Figure 3-4.

Differential configuration

When all of the analog input channels are configured for differential input mode, four analog channels are available. In differential mode, the input signal is measured with respect to the low input.

The input signal is delivered through three wires:

- The wire carrying the signal to be measured connects to CH<0, 2, 4, 6> IN. In differential mode, the even numbered channels are considered HI inputs. Hence, CH0 IN, CH2 IN, CH4 IN and CH6 IN are considered HI input channels.
- The wire carrying the reference signal connects to CH<1, 3, 5, 7> IN. In differential mode the odd numbered channels are considered the LO input. Hence, CH1 IN, CH3 IN, CH5 IN and CH7 IN are considered LO input channels.
- The third wire connects to GND.

When should you use a differential mode configuration?

Differential input mode is the preferred configuration for applications in noisy environments, or when the signal source is referenced to a potential other than PC ground.

A low-noise precision programmable gain amplifier (PGA) is available on differential channels to provide gains of up to 20 and a dynamic range of up to 16-bits.

In differential mode, the following two requirements must be met for linear operation:

- Any analog input must remain in the −10 V to +20 V range with respect to ground at all times.
- The maximum differential voltage on any given analog input pair must remain within the selected voltage range.

The input [*common-mode voltage + signal*] of the differential channel must be in the −10 V to +20 V range in order to yield a useful result.
For example, you input a 4 volt peak-to-peak (Vpp) sine wave to CHHI, and apply the same sine wave 180° out of phase to CHLO. The common mode voltage is 0 V. The differential input voltage swings from 4 V-(-4 V) = 8 V to -4 V-4 V = -8 V. Both inputs satisfy the -10 V to +20 V input range requirement, and the differential voltage is suited for the ±10 V input range (see Figure 3-5).

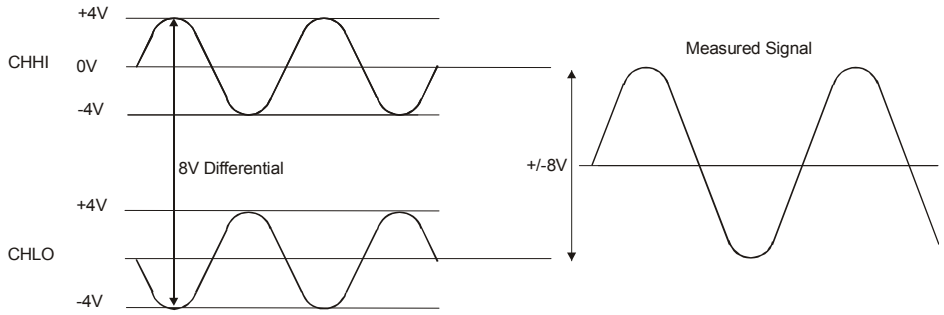


Figure 3-5. Differential voltage example: common mode voltage of 0 V

If you increase the common mode voltage to 11 V, the differential remains at ±8 V. Although the [*common-mode voltage + signal*] on each input now has a range of +7 V to +15 V, both inputs still satisfy the -10 V to +20 V input requirement (see Figure 3-6).

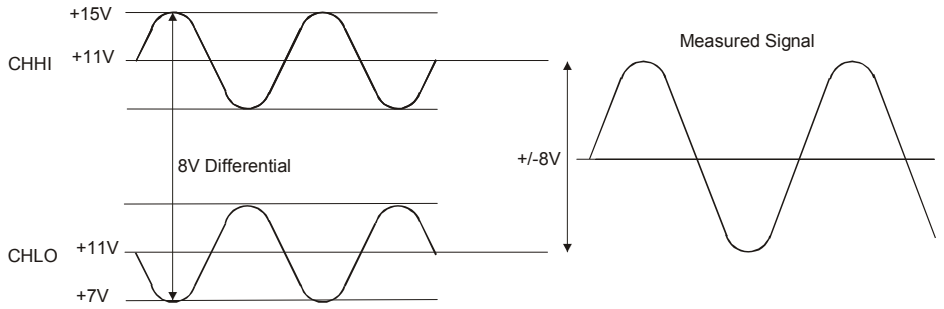


Figure 3-6. Differential voltage example: common mode voltage of 11 V

If you decrease the common-mode voltage to -7 V, the differential stays at ±8 V. However, the solution now violates the input range condition of -10 V to +20 V. The voltage on each analog input now swings from -3 V to -11 V. Voltages between -10 V and -3 V are resolved, but those below -10 V are clipped (see Figure 3-7).

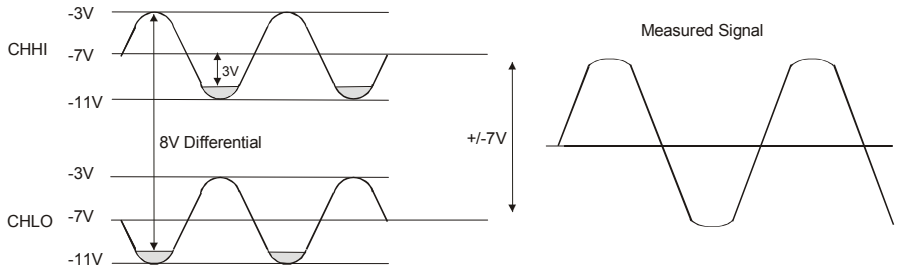


Figure 3-7. Differential voltage example: common mode voltage of -7 V

Since the analog inputs are restricted to a −10 V to +20 V signal swing with respect to ground, all ranges *except* ±20 V can realize a linear output for any differential signal with zero common mode voltage and full scale signal inputs. The ±20 V range is the exception. You cannot put −20 V on CHHI, and 0 V on CHLO, since this violates the input range criteria. Table 3-3 shows some possible inputs and the expected results.

Table 3-3. Sample inputs and differential results

CHHI	CHLO	Result
-20 V	0 V	Invalid
-15 V	+5 V	Invalid
-10 V	0 V	-10 V
-10 V	+10 V	-20 V
0 V	+10 V	-10 V
0 V	+20 V	-20 V
+10 V	-10 V	+20 V
+10 V	0 V	+10 V
+15 V	-5 V	+20 V
+20 V	0	+20 V

Additional information on analog signal connections

For general information regarding single-ended and differential inputs, refer to the *Guide to Signal Connections* (available on our web site at www.mccdaq.com/signals/signals.pdf).

Digital I/O terminals (DIO0 - DIO3)

Connect up to four digital I/O lines to the screw terminals containing pins **DIO0** to **DIO3**. Refer to the pinout diagrams on page 3-5 for the location of these pins. You can configure each digital channel independently for either input or output.

Overvoltage/short circuit protection is provided with a 1.5 kΩ series resistor on each I/O pin. Use of the resistor may limit the value of the output current, however. For example, if the output current is 1 mA, the resistor drops 1.5 V, resulting in an output of 3.5 V.

You can use the digital I/O terminals to detect the state of any TTL level input. In Figure 3-8, if the switch is set to the +5 V input, and the DIO0 reads TRUE (1). If the switch is moved to GND, the DIO0 reads FALSE.

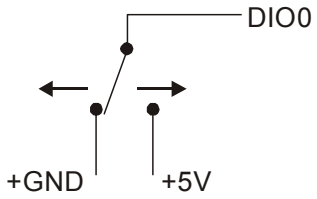


Figure 3-8. Digital connection DIO0 detecting the state of a switch

Additional information on digital signal connections

For general information regarding digital signal connections and digital I/O techniques, refer to the *Guide to Signal Connections* (available on our web site at www.mccdaq.com/signals/signals.pdf).

Power terminals

The **PC +5V** connections on the screw terminal draw power from the USB connector. The +5 V screw terminal is a 5 volt output that is supplied by the computer.

Caution! The PC +5V terminals are outputs. Do not connect an external power supply to a +5 V screw terminal, or you may damage the device and possibly the computer.

The maximum total output current that can be drawn from all miniLAB 1008 connections (power, analog and digital outputs) is 500 mA. This maximum applies to most personal computers and self-powered USB hubs. Bus-powered hubs and notebook computers may limit the available output current to 100 mA.

Just connecting the miniLAB 1008 to your computer draws 20 mA of current from the USB +5V supply. Once you start running applications with the device, each DIO bit can draw up to 2.5 mA, and each analog output can draw 30 mA. The maximum amount of +5 V current available to the user is the difference between the *total current requirement* of the PMD (based on the application), and the *allowed current draw* of the PC platform (again, 500 mA for desktop PCs and self-powered hubs, or 100 mA for bus-powered hubs and notebook computers).

With all outputs at their maximum output current, you can calculate the total current requirement of the miniLAB 1008 device's USB +5 V as follows:

(miniLAB 1008 @ 20 mA) + (4 DIO @ 2.5 mA ea) + (2 AO @ 30 mA ea) = 90 mA

For an application running on a PC or powered hub, this value yields a maximum user current of 500 mA − 90 mA = 410 mA. This number is the total maximum available current at the PC +5 V screw terminals. Measurement Computing highly recommends that you figure in a safety factor of 20% below this maximum current loading for your applications. A conservative, safe user maximum in this case would be in the 300-320 mA range.

Since laptop computers typically allow up to 100 mA, the miniLAB 1008 in a fully-loaded configuration may be above that allowed by the computer. In this case, you must determine the per-pin loading in the application to ensure that the maximum loading criteria is met. The per-pin loading is calculated by simply dividing the +5V by the load impedance of the pin in question.

Ground terminals

There are 9 identical ground connections that provide a common ground for all miniLAB 1008 functions. Refer to the pinout diagrams on page 3-5 for the location of the **GND** terminal pins.

Calibration terminal

The **CAL** connection on the output terminal provides a calibration reference voltage. This terminal should only be used during calibration of the miniLAB 1008 device.

Calibration of the miniLAB 1008 is software-controlled via *InstaCal*.

Testing terminal

The **TST** terminal is reserved for factory testing only.

Counter terminal

The input connection to the 32-bit external event counter is made to the screw terminal labeled **CTR**. Refer to the pinout diagrams on page 3-5 for the location of this pin. The internal counter increments whenever the CTR input voltage changes from <1 volt to more than 4 volts. The counter is capable of counting frequencies up to 1 MHz.

Accuracy

The overall accuracy of any instrument is limited by the error components within the system. Quite often, resolution is incorrectly used to quantify the performance of a measurement product. While "12-bits" or "1 part in 4096" does indicate what can be resolved, it provides little insight into the quality of an absolute measurement. Accuracy specifications describe the actual results that can be realized with a measurement device.

There are three types of errors which affect the accuracy of a measurement system:

- offset
- gain
- nonlinearity

The primary error sources in the miniLAB 1008 are offset and gain. Nonlinearity is small in the miniLAB 1008, and is not significant as an error source with respect to offset and gain.

Figure 3-9 shows an ideal, error-free, miniLAB 1008 transfer function. The typical calibrated accuracy of the miniLAB 1008 is range-dependent, as explained in the "Specifications" chapter of this document. We use a ±10 V range here as an example of what you can expect when performing a measurement in this range.

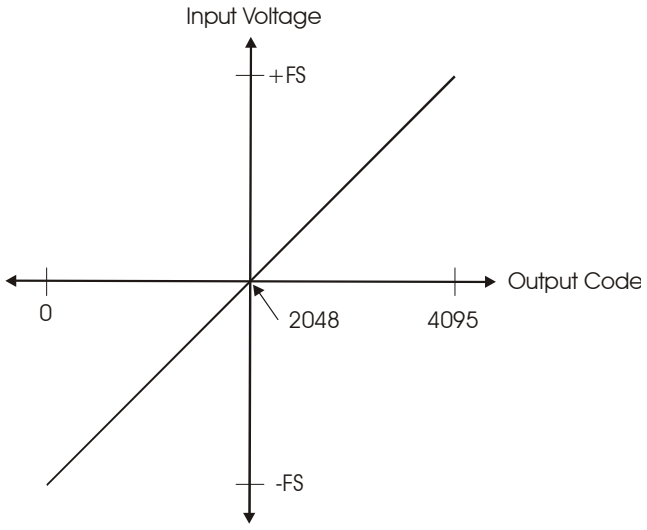


Figure 3-9. Ideal ADC transfer function

The miniLAB 1008's offset error is measured at mid-scale. Ideally, a zero-volt input should produce an output code of 2048. Any deviation from this is an offset error. Figure 3-10 shows the miniLAB 1008 transfer function with an offset error. The typical offset error specification on the ±10 V range is ±9.77 millivolts (mV). Offset error affects all codes equally by shifting the entire transfer function up or down along the input voltage axis.

The accuracy plots in Figure 3-10 are drawn for clarity and are not drawn to scale.

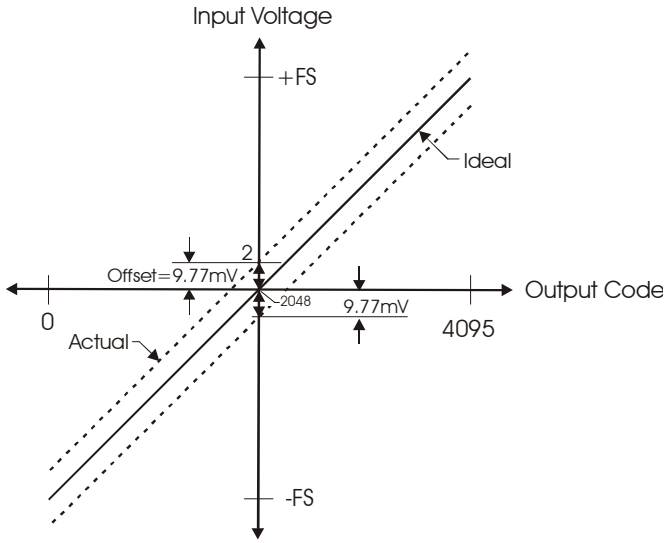


Figure 3-10. ADC transfer function with offset error

Gain error is a change in the slope of the transfer function from the ideal, and is typically expressed as a percentage of full-scale. Figure 3-11 shows the miniLAB 1008 transfer function with gain error. Gain error is easily converted to voltage by multiplying the full-scale (FS) input by the error.

The accuracy plots in Figure 3-11 are drawn for clarity and are not drawn to scale.

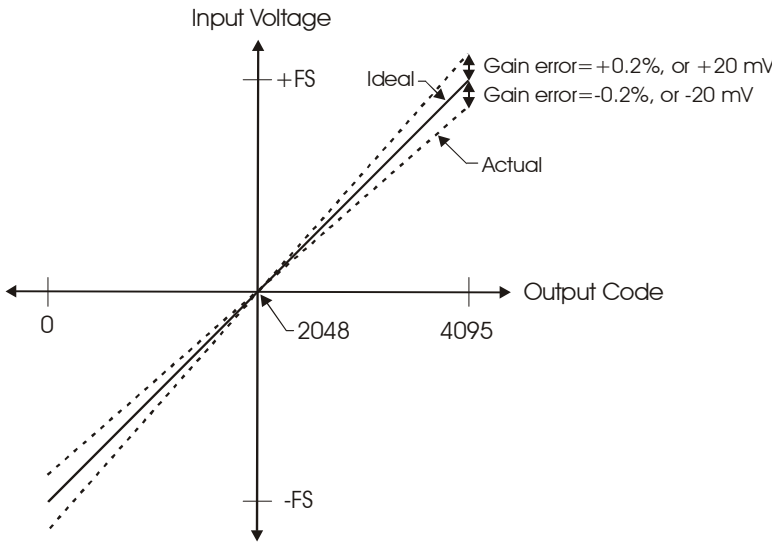


Figure 3-11. ADC Transfer function with gain error

For example, the miniLAB 1008 exhibits a typical calibrated gain error of ±0.2% on all ranges. For the ±10 V range, this would yield 10V × ±0.002 = ±20 mV. This means that at full scale, neglecting the effect of offset for the moment, the measurement would be within 20 mV of the actual value. Note that gain error is expressed as a ratio. Values near ±FS are more affected from an absolute voltage standpoint than are values near mid-scale, which see little or no voltage error.

Combining these two error sources in Figure 3-12, we have a plot of the error band of the miniLAB 1008 for the ±10 V range. This is a graphical version of the typical accuracy specification of the product.

The accuracy plots in Figure 3-12 are drawn for clarity and are not drawn to scale

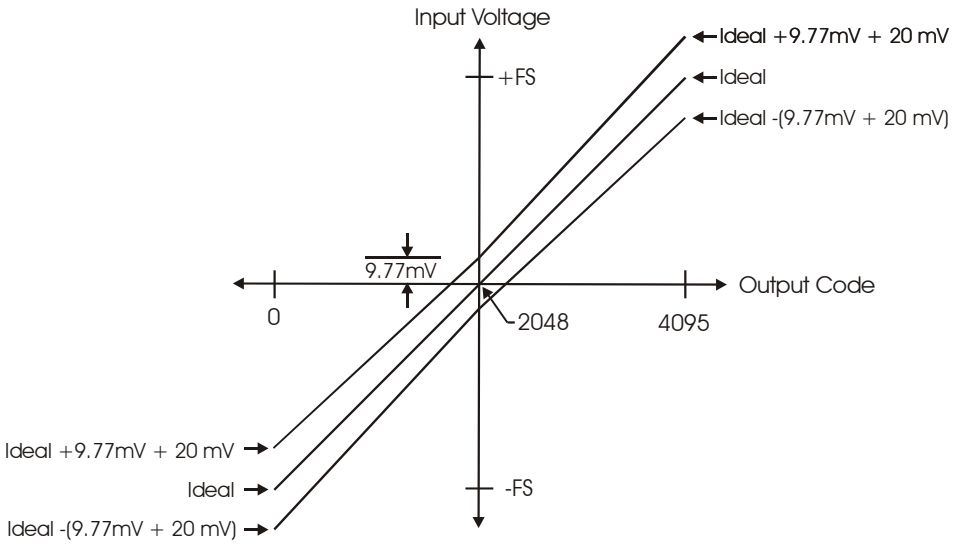


Figure 3-12. Error band plot

Channel gain queue

The miniLAB 1008's channel gain queue feature allows you to set up a scan sequence with a unique per-channel gain setting and channel sequence.

The channel gain queue feature removes the restriction of using an ascending channel sequence at a fixed gain. This feature creates a channel list which is written to local memory on the miniLAB 1008. This list is made up of a channel number and range setting. An example of a four-element list is shown in Table 3-4.

Table 3-4. Sample channel gain queue list

Element	Channel	Range
0	CH0	BIP10V
1	CH0	BIP5V
2	CH7	BIP10V
3	CH2	BIP1V

When a scan begins with the gain queue enabled, the miniLAB 1008 reads the first element, sets the appropriate channel number and range, and then acquires a sample. The properties of the next element are then retrieved, and another sample is acquired. This sequence continues until all elements in the gain queue have been selected. When the end of the channel list is detected, the sequence returns to the first element in the list.

This sequence repeats until the specified number of samples is gathered. You must carefully match the gain to the expected voltage range on the associated channel—otherwise, an over range condition can occur. Although this condition does not damage the miniLAB 1008, it does produce a useless full-scale reading. It can also introduce a long recovery time from saturation, which can affect the next measurement in the queue.

Digital connector cabling

Table 3-5 lists the digital I/O connector, applicable cables and accessory equipment. The x in the compatible cable name indicates the length in feet of the cable.

Table 3-5. Digital connector and accessory equipment

Connector type	37-pin D-type, shielded
Compatible cables	C37FF-x (Figure 3-13)
	C37FFS-x (Figure 3-14)
	C37FM-x (Figure 3-15)
Compatible accessory products	CIO-MINI37 SSR-RACK24 SSR-RACK08 CIO-ERB24 CIO-ERB08

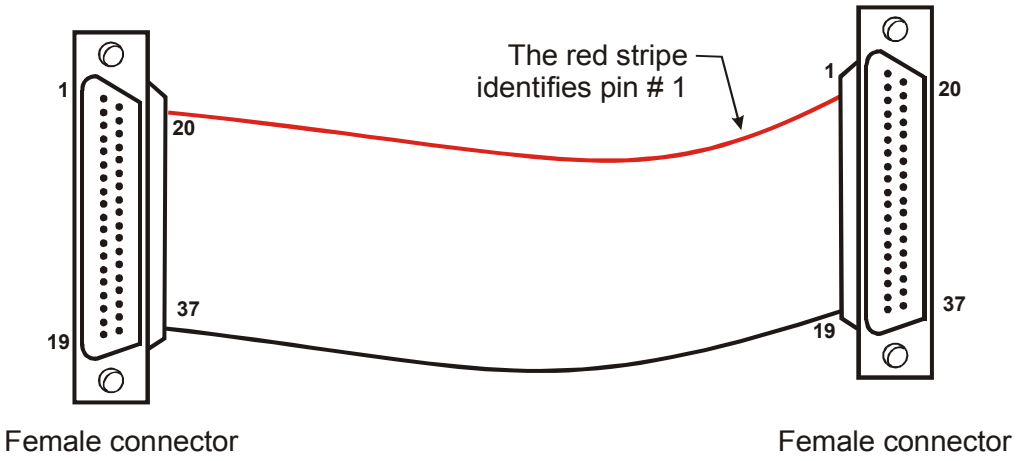


Figure 3-13. C37FF-x cable

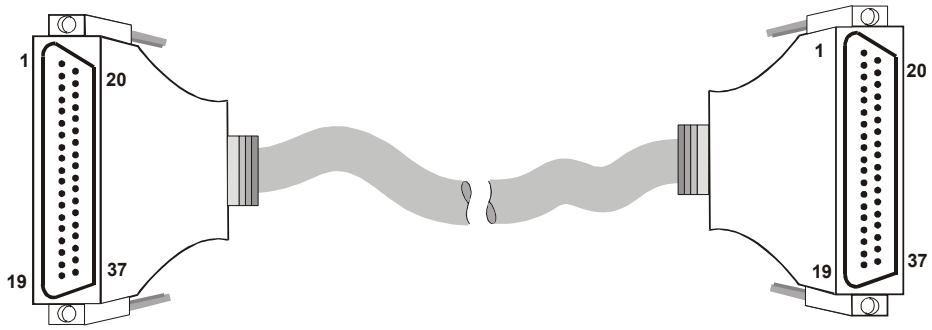


Figure 3-14. C37FFS-x cable

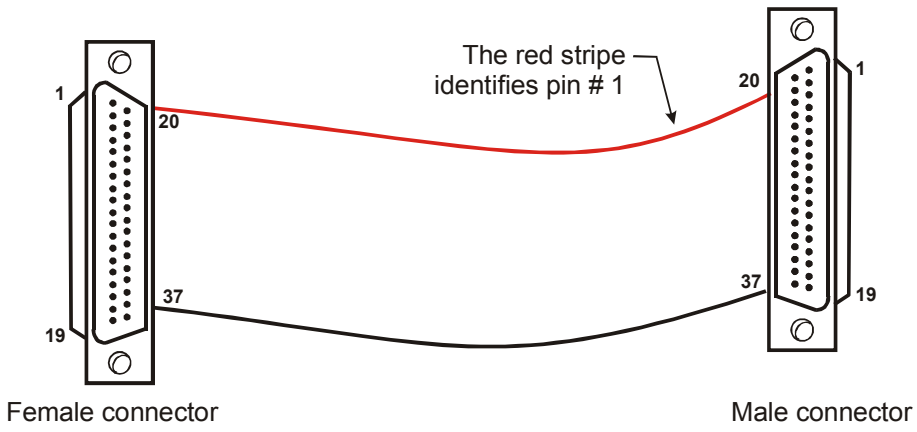


Figure 3-15. C37FM-x cable

Specifications

Typical for 25 °C unless otherwise specified.

Specifications in *italic text* are guaranteed by design.

Analog Input

Parameter	Conditions	Specification
A/D converter type		Successive approximation type
Input voltage range for linear operation, single-ended mode	CHx to GND	±10 V max
Input voltage range for linear operation, differential mode	CHx to GND	-10 V min, +20V max
Absolute maximum input voltage	*CHx to GND*	*±40 V max*
Input current (Note 1)	Vin = +10 V	70 µA typ
	Vin = 0 V	-12 µA typ
	Vin = -10 V	-94 µA typ
Number of channels		8 single-ended / 4 differential, software selectable
Input ranges, single-ended mode		±10 V, G=2
Input ranges, differential mode		±20 V, G=1 ±10 V, G=2 ±5 V, G=4 ±4 V, G=5 ±2.5 V, G=8 ±2.0 V, G=10 ±1.25 V, G=16 ±1.0 V, G=20 Software selectable
Throughput	Software paced	50 S/s
	Continuous scan	1.2 kS/s
	Burst scan to 4K sample FIFO	8 kS/s
Channel gain queue	Up to 8 elements	Software configurable channel, range, and gain.
Resolution (Note 2)	Differential	12 bits, no missing codes
	Single-ended	11 bits
CAL accuracy	CAL = 2.5 V	±0.05% typ, ±0.25% max
Integral linearity error		±1 LSB typ
Differential linearity error		±0.5 LSB typ
Repeatability		±1 LSB typ
CAL current	Source	5 mA max
	Sink	20 µA min, 200 nA typ
Trigger source	Software selectable	External digital: DIO0-DIO3

Note 1: Input current is a function of applied voltage on the analog input channels. For a given input voltage, Vin, the input leakage is approximately equal to (8.181*Vin-12) µA.

Note 2: The AD7870 converter only returns 11-bits (0-2047 codes) in single-ended mode.

Table 6. Accuracy, differential mode

Range	Accuracy (LSB)
±20 V	5.1
±10 V	6.1
±5 V	8.1
±4 V	9.1
±2.5 V	12.1
±2 V	14.1
±1.25 V	20.1
±1 V	24.1

Table 7. Accuracy, single-ended mode

Range	Accuracy (LSB)
±10 V	4.0

Table 8. Accuracy components, differential mode - all values are (±)

Range	% of Reading	Gain Error at FS (mV)	Offset (mV)	Accuracy at FS (mV)
±20 V	0.2	40	9.766	49.766
±10 V	0.2	20	9.766	29.766
±5 V	0.2	10	9.766	19.766
±4 V	0.2	8	9.766	17.766
±2.5 V	0.2	5	9.766	14.766
±2 V	0.2	4	9.766	13.766
±1.25 V	0.2	2.5	9.766	12.266
±1 V	0.2	2	9.766	11.766

Table 9. Accuracy components, single-ended mode

Range	% of Reading	Gain Error at FS (mV)	Offset (mV)	Accuracy at FS (mV)
±10 V	0.2	20	19.531	39.531

Analog output

Parameter	Conditions	Specification
D/A converter type		PWM
Resolution		10-bits, 1 in 1024
Maximum output range		*0 -5 Volts*
Number of channels		2 voltage output
Throughput	Software paced	100 S/s single channel mode 50 S/s dual channel mode
Power on and reset voltage		Initializes to 000h code
Maximum voltage (Note 3)	No load	Vs
	1 mA load	0.99 * Vs
	5 mA load	0.98 * Vs
Output drive	Each D/A OUT	30 mA
Slew rate		0.14 V/mS typ

Note 3: Vs is the USB bus +5V power. The maximum analog output voltage is equal to Vs at no-load. V is system dependent and may be less than 5 volts.

Digital input / output (screw terminal DIO3:0)

Parameter	Conditions	Specification
Digital type		Discrete, 5V/TTL compatible
Number of I/O		4
Configuration		4 bits, independently programmable for input or output.
Input high voltage		3.0 V min, 15.0 V absolute max
Input low voltage		0.8 V max
Output voltage (Note 4)	No load	Vs - 0.4 V min, Vs typ
	1 mA load	Vs - 1.5 V
Input leakage current		*±1.0 µA*
Output short-circuit current (Note 4)	Output high	3.3 mA
Power-up / reset state		Input mode (high impedance)

Note 4: The DIO[3:0] lines available at the screw terminals are protected with 1.5 KOhm series resistors.

Digital input / output (DB37)

Digital type	82C55
Number of I/O	24 (Port A0 through Port C7)
Configuration	2 banks of 8 and 2 banks of 4, or 3 banks of 8
Pull up/pull-down configuration	All pins pulled up to Vs via 47K resistors (default). Positions available for pull down to ground. Hardware selectable via zero ohm resistor.
Input high voltage	2.0 V min, 5.5 V absolute max
Input low voltage	0.8 V max, –0.5 V absolute min
Output high voltage (IOH = -2.5 mA)	3.0 V min
Output low voltage (IOL = 2.5 mA)	0.4 V max

External trigger

Parameter	Conditions	Specification
Trigger source	External digital	DIO[3:0], only DIO may be selected as a trigger input
Trigger mode	Software selectable	Level sensitive: user configurable for TTL level high or low input.
Trigger latency	Burst	25 µs min, 50 µs max
Trigger pulse width	Burst	40 µs min
Input high voltage		3.0 V min, 15.0 V absolute max
Input low voltage		0.8 V max
Input leakage current		*±1.0 µA*

Counters

Counter type	Event counter
Number of channels	1
Input source	*CTR screw terminal*
Input type	TTL, rising edge triggered
Resolution	32 bits
Schmidt trigger hysteresis	*20 mV to 100 mV*
Input leakage current	*±1 µA*
Maximum input frequency	1 MHz
High pulse width	*500 ns min*
Low pulse width	*500 ns min*
Input low voltage	0V min, 1.0 V max
Input high voltage	4.0 V min, 15.0 V max

Non-volatile memory

Memory size	8192 bytes		
Memory configuration	Address Range	Access	Description
	0x0000 – 0x17FF	Read/Write	A/D Data (4k samples)
	0x1800 – 0x1EFF	Read/Write	User data area
	0x1F00 – 0x1FEF	Read/Write	Calibration Data
	0x1FF0 – 0x1FFF	Read/Write	System Data

Power

Parameter	Conditions	Specification
Supply Current (Note 5)		20 mA
+5V USB power available (Note 6)	Connected to Self-Powered Hub	4.5 V min, 5.25 V max
	Connected to Bus-Powered Hub	4.1 V min, 5.25 V max
Output Current (Note 7)	Connected to Self-Powered Hub	450 mA min, 500 mA max
	Connected to Bus-Powered Hub	50 mA min, 100 mA max

Note 5: This is the total current requirement for the miniLAB-1008 which includes up to 5mA for the status LED.

Note 6: Self-powered refers to USB hubs and hosts with a power supply. Bus-powered refers to USB hubs and hosts without their own power supply.

Note 7: This refers to the total amount of current that can be sourced from the USB +5V, analog outputs and digital outputs.

General

Parameter	Conditions	Specification
USB controller clock error	*25 °C*	*±30 ppm max*
	0 to 70 °C	*±50 ppm max*
	-40 to 85 °C	*±100 ppm max*
Device type		USB 1.1 low-speed
Device compatibility		USB 1.1, USB 2.0

Environmental

Operating temperature range	-40 to 85 °C
Storage temperature range	-40 to 85 °C
Humidity	0 to 90% non-condensing

Mechanical

Case dimensions	157 mm (L) x 102 mm (W) x40 mm (H) , including connectors
USB cable length	*3 meters max*
User connection length	*3 meters max*

Main connector and pin out

Connector type	Screw terminal
Wire gauge range	12 AWG to 22 AWG

4-channel differential mode

Pin	Signal Name	Pin	Signal Name
1	CH0 IN HI	16	DIO0
2	CH0 IN LO	17	DIO1
3	GND	18	GND
4	CH1 IN HI	19	DIO2
5	CH1 IN LO	20	DIO3
6	GND	21	GND
7	CH2 IN HI	22	D/A OUT 0
8	CH2 IN LO	23	D/A OUT 1
9	GND	24	GND
10	CH3 IN HI	25	CTR
11	CH3 IN LO	26	GND
12	GND	27	GND
13	PC +5V	28	PC +5V
14	PC +5V	29	PC +5V
15	CAL	30	TST

8-channel single-ended mode

Pin	Signal Name	Pin	Signal Name
1	CH0 IN	16	DIO0
2	CH1 IN	17	DIO1
3	GND	18	GND
4	CH2 IN	19	DIO2
5	CH3 IN	20	DIO3
6	GND	21	GND
7	CH4 IN	22	D/A OUT 0
8	CH5 IN	23	D/A OUT 1
9	GND	24	GND
10	CH6 IN	25	CTR
11	CH7 IN	26	GND
12	GND	27	GND
13	PC +5V	28	PC +5V
14	PC +5V	29	PC +5V
15	CAL	30	TST

DB37 connector and pin out

Connector type	37 D-Type, shielded
Compatible Cables	C37FF-x
	C37FFS-x
	C37FM-x
Compatible accessory products	CIO-MINI37 SSR-RACK24 SSR-RACK08 CIO-ERB24 CIO-ERB08

Pin	Signal Name	Pin	Signal Name
1	n/c	20	USB +5V Out
2	n/c	21	GND
3	Port B7	22	Port C7
4	Port B6	23	Port C6
5	Port B5	24	Port C5
6	Port B4	25	Port C4
7	Port B3	26	Port C3
8	Port B2	27	Port C2
9	Port B1	28	Port C1
10	Port B0	29	Port C0
11	GND	30	Port A7
12	n/c	31	Port A6
13	GND	32	Port A5
14	n/c	33	Port A4
15	GND	34	Port A3
16	n/c	35	Port A2
17	GND	36	Port A1
18	USB +5V Out	37	Port A0
19	GND		

CE Declaration of Conformity

Manufacturer: Measurement Computing Corporation
Address: 10 Commerce Way
Suite 1008
Norton, MA 02766
USA

Measurement Computing Corporation declares under sole responsibility that the product

miniLAB 1008

to which this declaration relates is in conformity with the relevant provisions of the following standards or other documents:

EU EMC Directive 89/336/EEC: Electromagnetic Compatibility, EN 61326 (1997) Amendment 1 (1998)

Emissions: Group 1, Class A

- EN 55011 (1990)/CISPR 11: Radiated and Conducted emissions.

Immunity: EN61326, Annex A

- IEC 1000-4-2 (1995): Electrostatic Discharge immunity, Criteria C.
- IEC 1000-4-3 (1995): Radiated Electromagnetic Field immunity Criteria A.
- IEC 1000-4-8 (1994): Power Frequency Magnetic Field immunity Criteria A.

Power line and I/O tests to IEC 1000-4-4, IEC 1000-4-5, IEC 1000-4-6, and IEC 1000-4-11 were not required. The device is DC powered from an I/O cable which is less than three meters long.

Declaration of Conformity based on tests conducted by Chomerics Test Services, Woburn, MA 01801, USA in June, 2004. Test records are outlined in Chomerics Test Report #EMI3902.04.

We hereby declare that the equipment specified conforms to the above Directives and Standards.

Carl Haapaoja, Director of Quality Assurance

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